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REMARKS

Claims 1-16 and 18-24, all the claims presently pending in the application, stand rejected on prior art grounds. This Amendment amends claim 10.

It is noted that the claims are amended to merely clarify the subject matter of the claims and not to narrow the scope of the claims in order to overcome the prior art or for any statutory purposes of patentability. Notwithstanding any claim amendments of the present Amendment or those amendments that may be made during prosecution, Applicant's intent is to encompass equivalents of all claim elements. Attached hereto is a marked up version of the changes made in the specification and/or claims by the current Amendment.

With respect to the prior art rejections, claims 1-4 stand rejected under 35 U.S.C. § 102(b) as anticipated by McTeer (U.S. Patent No. 5,939,788). Claims 21 and 22 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over McTeer in view of Parikh (U.S. Patent No. 6,225,207). Claims 5-16, 18-20, 23, 24 stand rejected under 35 U.S.C. § 102(b) as anticipated by Parikh.

The prior art rejections are respectfully traversed in view of the following discussion.

I. THE CLAIMED INVENTION

Applicant's invention, as disclosed and defined in claim 1, is directed to a method of forming an interconnect on a semiconductor substrate that includes forming a relatively narrow first structure in a dielectric formed on a semiconductor substrate, forming a relatively wider

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second structure in the dielectric formed on the semiconductor substrate, forming a liner in the first and second structures such that the first structure is substantially filled and the second substrate is substantially unfilled, and forming a metallization over the liner to completely fill the second structure.

The conventional method typically attempts to fill substantially both small and large contact structures with copper, thereby requiring additional and costly processing. For example, it is difficult to adequately line contacts for copper filling at contact dimensions below 280 nm and to line contacts reliably below contact opening sizes of less than 320 nm. The conventional methods present a major challenge to dynamic random access memory back-end-of-line (DRAM BEOL) processing when applying copper to line contacts.

The claimed method, on the other hand, forms a liner in an exemplary first relatively narrow contact structure and an exemplary second relatively wider contact structure that is formed on a semiconductor substrate, and subsequently forms a metallization over the liner to completely fill the second structure. This is important because small contacts on a semiconductor device can be filled with a highly reliable material and wider metal lines, or slots, can be filled with copper.

Thus, advantages to the invention include filling the substantially smaller areas and structures with CVD metal, and the wider areas and structures with copper metallization.

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II. THE PRIOR ART REJECTIONS

THE MCTEER REFERENCE

The Examiner alleges claims 1-4 are anticipated by McTeer. Applicant submits, however, that there are elements of the claimed invention which are not found in McTeer.

The Examiner alleges that column 23 and Figure 16 of McTeer teach "forming relatively narrow first structure at the bottom of the dual damascene structure in a dielectric (14) formed on the semiconductor substrate; forming a relatively wider second structure at the top of the dual damascene structure in the dielectric," (emphasis Applicant's) in the context of the claims.

Applicant respectfully submits that the Examiner is incorrect.

First, the Examiner has quoted limitations not found in claim 1. Claim 1 recites a . . . "relatively narrow first structure in a dielectric formed on a semiconductor substrate; forming a relatively wider second structure in said dielectric formed on the semiconductor substrate. . ." Claim 1 does not contain a limitation of a structure at "the bottom" or "at the top of" a dual damascene structure.

Further, there is no teaching or suggestion in McTeer of "forming a relatively wider second structure in said dielectric formed on the semiconductor substrate," as recited in claim 1 (emphasis Applicant's) In Figure 16 and column 23, McTeer discloses a first opening above plug 8 in a second insulating layer 9. Then, McTeer forms the second opening above the (filled) first opening in a third insulating layer.

This disparate structure of McTeer is contrasted to the claimed invention that forms the

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second damascene structure in the same dielectric as the first structure. The claimed "relatively narrow first structure" is formed in "a dielectric" and the "relatively wider second structure" is formed in "said dielectric," which refers to the dielectric layer of the first structure. For the Examiner's greater clarity and understanding, in a non-limiting exemplary embodiment illustrated in Figure 2, both the C1 Slot and C1 Contact are formed in the C1/M1 Dielectric. This is far different from McTeer's Figure 16, wherein the bottom hole filled by barrier 18 is formed in a different insulating layer 9 than the hole that is lined with barrier 19 formed in dielectric layer 14. Forming structures in two different layers cannot possibly anticipate or suggest forming two structures in the same layer. Thus, there is no teaching or suggestion of "forming a relatively wider second structure in said dielectric formed on the semiconductor substrate," as recited in claim 1 (emphasis Applicant's).

Further, the Examiner alleges that McTeer discloses "forming a liner (2) comprising aluminum and titanium nitride (line 48) in the first and second structures," in the context of the claims. Applicant submits that this statement is an incorrect interpretation of McTeer and further that McTeer does not anticipate the claimed element. Claim 1 actually recites "forming a liner in said first and second structures such that said first structure is substantially filled and said second structure is substantially unfilled" (emphasis Applicant's).

In McTeer, the bottom hole is lined by Aluminum diffusion layer 18 and wetting layer 19, and filled with Aluminum 16. However, the upper hole is filled with a different material than Aluminum 16.

Applicant pointing to a different structure, 16, 18, 19 are not mentioned by the examiner

McTeer discloses leads on Claim 1-4

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Therefore, this is a different method than the claimed damascene structure comprising the same liner formed in both the first and second structures (e.g., “a liner in said first and second structures”). McTeer forms a $Ti_xAl_yN_z$ liner 2 in the upper structure only, not in the lower structure. Therefore, McTeer uses two different liners, and therefore cannot possibly anticipate or suggest the claimed invention. Thus, there is no teaching or suggested of “forming a liner in said first and second structures,” as recited in claim 1 (emphasis Applicant’s).

Further, the Examiner alleges that Figure 16 and column 23 of McTeer discloses “forming a liner . . . such that the first structure is substantially filled and the second structure is substantially unfilled” in the context of the claims.

However, Applicant submits that McTeer discloses a method that is far different than the claimed invention. As is clear, McTeer discloses forming a first structure, lining the first structure with layers 18 and 19, and filling the first structure with Aluminum 16. Then, McTeer forms the second structure, on the first structure, that is lined with liner 2 and filled with copper 3, after the first structure is filled. Therefore, McTeer does not teach or suggest forming the same liner (e.g., “a liner” in present claim 1) in both structures wherein the first structure is substantially filled and the second structure is substantially unfilled. McTeer’s structures uses not only different liners (e.g., Aluminum liner 18 in the first structure and $Ti_xAl_yN_z$ liner in the second structure) but also does not substantially fill or unfill either structure with a liner.

Thus, there is no teaching or suggestion of “forming a liner in said first and second structures such that said first structure is substantially filled and said second structure is

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substantially unfilled,” as recited in claim 1 (emphasis Applicant’s).

For the reasons stated above, claims 1-4 are fully patentable over the McTeer. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw the rejection.

THE PARIKH REFERENCE

The Examiner alleges claims 5-6, 18-20, 23, and 24 are anticipated by Parikh. Applicant submits, however, that there are elements of the claimed invention which are not found in Parikh.

The Examiner alleges that columns 14-16 and Figures 9A-9F disclose “depositing a metal comprising copper over the conducting material in column 16, lines 51-57; adjusting the thickness of the metal to fill completely the slot and troughs, in column 15, lines 11-13; removing the conducting material and the metal back to the dielectric (916)” in the context of the claims. However, these passages merely recite a method for completely filling trench 924 and via 926 with a conductive material (950, 952, and 956 in Fig. 9F). An incidental, additional embodiment discloses an optional metal liner under the conductive material, which is a far different method than the claimed invention.

As is clear, there is no teaching or suggestion of “depositing a metal over the conducting material to completely fill the slot and troughs,” as recited in claims 5 and 16. In fact, Parikh discloses an opposite method that is contradictory to the claimed invention. Parikh discloses depositing a metal liner “inside the via holes and trenches” and that “the lined via holes and trenches are then simultaneously filled with a conductive material,” (col. 16, lines 44-55).

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Parikh's drawings do not even show such a configuration, while in a non-limiting exemplary embodiment shown in Figures 2 and 3 of the present Application, an exemplary tungsten liner (e.g., conductive material) is lined in the slot C1 and contact C1 while the metal (e.g., copper) is deposited above the conductive material to completely fill the slot C1 and contact C1. Thus, there is no disclosure or suggestion of depositing a metal over a conducting material.

Further, Parikh does not teach or suggest completely filling the slot and troughs with a metal that is deposited over the conducting material. As is clear, Parikh discloses depositing a metal liner, such as copper, and thereafter "the lined via holes and trenches are . . . filled with a conductive material" (col. 16, lines 51-57). In contrast, as illustrated exemplarily in Figures 3 and 4, the claimed invention fills the slot and contact with a metal after lining the same with the conductive material.

Indeed, the Examiner admits that Parikh cannot anticipate claims 5 and 16. The Examiner, on page 2 of the Office Action, states that "the examiner understands that the slot is filled completely with the metal and not by conducting material as claimed in the dependent claim 10." Thus, it is clear that Parikh does not teach or suggest the novel method of, "depositing a metal over the conducting material to completely fill the slot and troughs," as recited in claims 5 and 16.

For at least the reasons outlined above, Applicant respectfully submits that Parikh fails to teach or suggest every feature of claims 5-16, 18-20, and 23-24. Therefore, Applicant respectfully requests the Examiner to reconsider and withdraw the rejection.

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The Examiner alleges that claims 21 and 22 are unpatentable over McTeer in view of Parikh. Applicant submits, however, that there are elements of the claimed invention which are neither taught nor suggested by the Examiner's urged combination of references.

First, Applicant asserts that McTeer would not have been combined with Parikh as alleged. McTeer discloses a method to a first hole with a first liner and a first material, and then fill a second hole with a second liner and a second material. Parikh, however, fills two holes simultaneously with a conductive material, and alternatively, forms the same metal liner in the two holes and then fills the holes with the same conductive material. Thus, the use of different materials and serial timing of filling two holes by McTeer would not have been combined with Parikh's simultaneous filling of two holes by a single conductive material.

However, even if the references were combined, the combination would not teach each and every feature of the claimed invention. Further, the Examiner admits that McTeer "lacks forming the relatively narrow first structure not being connected to the relatively wider second structure and forming the wider second structure apart from the relatively narrow first structure," and alleges that Parikh discloses these features. However, Applicant submits that the deficiencies of McTeer are described above and that Parikh fails to make up for these deficiencies.

Therefore, Applicant submits that claims 21 and 22 are fully patentable over the cited references. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw the rejection.

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Thus, turning to the clear language of claim 1, there is no teaching or suggestion of "forming a liner in said first and second structures such that said first structure is substantially filled and said second structure is substantially unfilled; and forming a metallization over said liner to completely fill said second structure," nor is there teaching or suggestion of "depositing a conducting material on the dielectric; depositing a metal over the conducting material to completely fill the slot and troughs; removing the metal either to the conducting material or both the metal and the conducting material simultaneously back to the dielectric; and selectively removing the conducting material," as recited in independent claims 5 and 16.

For the reasons stated above, the claimed invention is fully patentable over the cited references. In view of the foregoing, the Examiner is respectfully requested to reconsider and withdraw the rejections.

III. FORMAL MATTERS AND CONCLUSION

Regarding the objection to claim 10, the Applicant has amended the claim to overcome the Examiner's objection.

In view of the foregoing, Applicant submits that claims 1-16 and 18-23, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to withdraw the rejections and pass the above application to issue at the earliest possible time.

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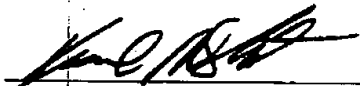
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Should the Examiner find the application to be other than in condition for allowance, the Examiner may contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Assignee's Deposit Account No. 50-0510.

Respectfully Submitted,

Date:

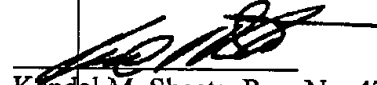
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CERTIFICATION OF FACSIMILE TRANSMISSION

I hereby certify that the foregoing Amendment was filed by facsimile with the United States Patent and Trademark Office, Examiner Keshavan, Belur V., Group Art Unit # 2825 at fax number 703-308-7721 this 9th day of July, 2003.


Kendal M. Sheets, Reg. No. 47,077